WESTERN STATES
DRILLING AND BLASTING, INC.

SEISMOGRAPH SPECIFICATIONS

EXAD-8
&
eXAD Vibration Analysis Tools Version 2 for Windows™

Operational Overview

The EXAD-8 and eXAD Vibration Analysis software is a combined hardware & software approach to recording and analyzing blast & construction vibration. The system is very powerful but is easy to use with just a little understanding of the eXAD system vocabulary. There are two main areas that will be discussed, EXAD-8 control and operations, and Analysis of EXAD-8 data on your computer.

The main steps for making a recording using the eXAD are simple, but very important. These include:

1. Configure the EXAD-8 system for recording vibration and sound. The basic configuration is to set the EXAD-8 for trigger mode, trigger source, trigger level, record time (this is how long the eXAD should record after triggering), sound measurement type (linear, and enter the ID#.

2. Remove the geophone (& geophone cable) and microphone from their storage locations. Connect the geophone to the eXAD-8 using the supplied cable (red connector) and place the geophone with the x axis pointing toward the blast. If possible, bury the geophone in the sub soil as this will provide the most accurate measurements. Remove the microphone from its strap and connect. Turn the system ON and check the battery voltage and the amount of available memory that you have remaining (this is in percentage of available memory). Return to Main Menu and Select **Measure** and press **ENT**. Select **Single or Continuous**, enter the **ID number** (identification number) and press ENT. Press ENT one more time to get to **Waiting for Trigger.** After the blast, note the measurements and press ESC until the Main Menu is displayed.

3. Connect the EXAD-8 to your computer using the supplied eXAD to PC serial cable. Start the eXAD software and switch on the EXAD-8. Enter any report information that you wish to have stored with each recording. Select **eXAD Control,** then select **Retrieve eXAD Data**. Enter the desired **Report Data**, and select the directory (**Data Path**) where you wish the data stored. Select the event or all events that you wish transferred.

4. After the data has been stored, your are now able to **Select** a **Record** (an EXAD-8 recording) and view that recording on the display by selecting **Vibration Analysis Tools** under **Analysis**. When you wish to print a complete report, select **eXAD Print** under **File operations.**

PC Hardware Requirements

Requirements Include:

- Hard Disk with 10 Mb Free
- Pentium or Higher
- Microsoft Windows 95 or Higher
- VGA or higher resolution screen supported by Microsoft Windows
- CD Rom
- Serial Port (or USB with USB to Serial Converter)

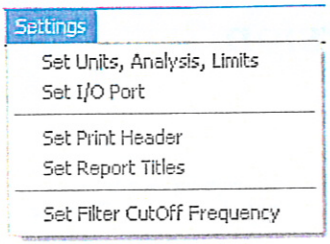
Installation

Insert CD containing eXAD Vibration Analysis Tools software.
From the Start Menu: Select Run , Browse to the CD Drive, and select Setup.exe

This will install all support files in the appropriate places on your hard disk, and create the Program Files\PMT\eXAD800 application directory, and Program Files\PMT\eXAD\DAT subdirectory, and install a sample data file (as used in the manual). Occasionally it will be necessary to exit from other running applications. **If the Microsoft Office toolbar is used, it is necessary to click on the toolbar and then stop running the application.**

Settings: eXAD Software

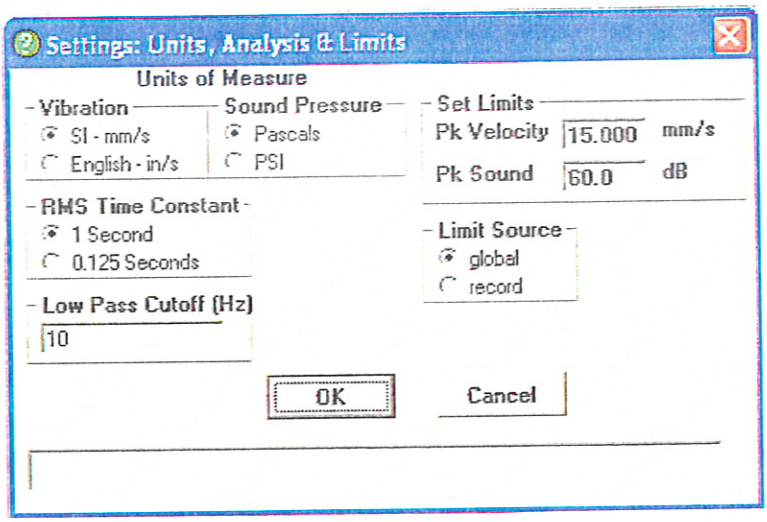
Custom Software Settings



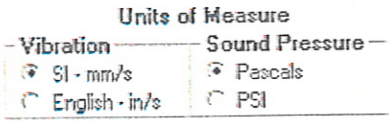
To properly use the eXAD software and provide for customized reports, the software must be configured. All configuration selections can be changed at any time. The Settings Choices are:

Set Units & Analysis

Two general groups of controls are displayed, Units of Measure and Analysis.



Units of Measure



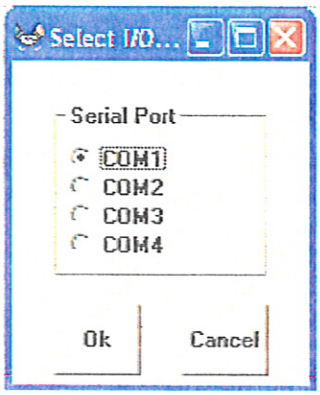
The Units of Measure group allows selection of the appropriate units for the area in which you are working. Specifically, units can be selected for vibration and sound pressure level. The choices depend on what is customary to use in your country, and any specifications against which you may compare. Please keep in mind that SI units are the international standard but can be directly converted to other systems.

Low Pass Cutoff (Hz) - This entry box allows the user to enter the low pass cutoff frequency. The cutoff frequency is specified in Hertz (Hz) and marks the -3db cutoff point.

RMS Time Constant (Hz) - In analysis where RMS vibration level is to be analyzed a selection should be made for the RMS time constant. In general the slow time constant is used (mainly for general vibration).

Set Limits – This allows vibration and peak sound pressure level limitation to be set.

Set I/O Ports



The choice made here is dependent on your PC hardware and how it is configured. The **Serial Port** is used for communication with the EXAD-8. The Serial Port choices are **COM1** to **COM4**. Almost all computers have at least COM1 available, and most have COM1 and COM2. Make sure that you select an available port. Check with your computer manual for the appropriate selection. Click on the appropriate selections and then click on the OK button.

Note: The EXAD-8 will not communicate properly with the computer while Hot Sync is active. Right mouse click on the Hot Sync icon and exit. This will reactivate when the computer restarts.

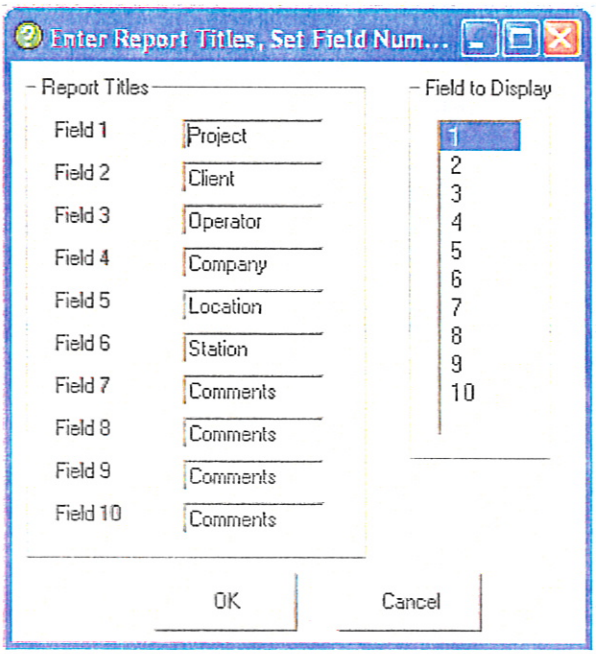
Set Print Header

This selection allows you to enter your company information that will be printed (centered) at the top of the first page of the formal report. Up to 48 characters for two lines can be entered. This will be printed at the top of page 1 of the report

Example: Physical Measurement Technologies
Keene, New Hampshire, USA

Enter Report Titles, Set Field Number

The eXAD software allows you to keep report information with each recording. The report data helps to identify the recording and any special information that is relevant. The report is comprised of 10 fields, including a title, and the report data. The report data will be printed on the first page (measurements page) of the formal report. Ten titles, of 10 characters each, can be entered.



This information is used to fully identify the report. Its use is not required by the eXAD software. The EXAD-8 has a facility for selecting an Identification Number which is stored with the recorded data in the instrument. That ID Number will be transferred with the data to the PC and stored in field number 6.

Field to Display
This allows the operator to select which field of the report data that will be displayed with each file (under Select Record) as a file identifier, and printed on each page of the formal report. If, for example, Project is Report Title number 1, and field number 1 is selected, the information that is entered in this field will be displayed when the list of files is displayed, and also printed on each page of the formal report.

Set Data Path

This is set under the File choice of the top menu bar (not under Configure). This tells the eXAD software where to put the data that is transferred from the eXAD system and where to find the data when you wish to analyze. A list of available directories is displayed. It is suggested that you use the DAT directory that was made under the installation data.

EXAD-8 Control and Configuration

To use the EXAD-8 for recording data, the instrument must be configured appropriately for the operations in which it will be used. The time and date should be set to local time. When it arrives, the EXAD-8 will be set to US Eastern time. Partial Configuration of the EXAD-8 can be performed through the EXAD-8 keyboard or the PC. Complete Configuration can only be performed through the PC. Retrieval of EXAD-8 stored data can only be performed using the PC. The EXAD-8 real time clock can be set through the PC or EXAD-8 keyboard.

EXAD-8 to PC Serial Communications

Communication between the EXAD-8 and the PC is under software control, and is really very simple. Connect the eXAD to PC serial cable, to the PC COM (serial) port which was selected under Configuration, and to the **Serial I/O** connector on the EXAD-8. This is the hardware link between your EXAD-8 and PC. The PC end of the cable is a 9 pin female connector. This has become the standard, particularly for notebook PC serial connectors. If your PC has a 25 pin serial connector, a 25 pin to 9 pin adapter can be purchased at any personal computer or electronics store. The EXAD-8 end of the cable is a 9 pin male connector. Normally, the connection should be made with the EXAD-8 switched into the Off position and the PC turned off.

After the connection has been made, switch the PC on and start the eXAD software. Switch the EXAD-8 to the On position. Watch the EXAD-8 display until the Main Menu is visible. **Any PC to EXAD-8 Communications can only be made when the EXAD-8 Main Menu is Visible.** In the eXAD software, select **eXAD Control**, click on **eXAD Communications**. This will take you to the eXAD Communications program. Select **eXAD Control**. The choices are:

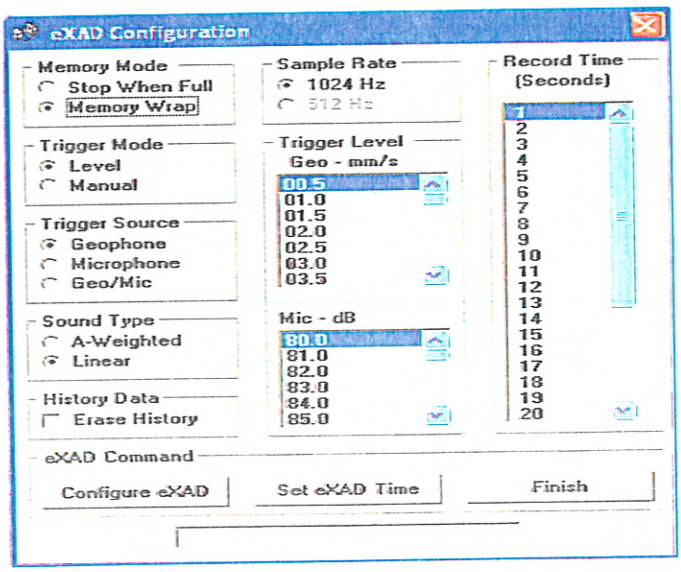
Configure eXAD
Retrieve eXAD Data

Configure eXAD

Configuration of the EXAD-8 consists of setting its operating parameters. Those can be set either through the EXAD-8 keyboard or through the PC. Partial configuration is allowed through the EXAD-8 keyboard, while a complete configuration can only be accomplished through the PC.

Very Important: Configuring the EXAD-8 through the PC will clear the EXAD-8 memory of stored events. Make sure that any events that you wish to save were Retrieved before configuring.

When the Configure eXAD selection is made, a window will open which shows the operating parameters and their choices. The configuration elements or operating parameters, and how the configuration can be made, are listed as follows:



Parameter	EXAD-8	PC
Memory Mode		X
Sample Rate	X	X
Trigger Mode	X	X
Trigger Level	X	X
Record Time	X	X (When Memory Mode is Stop When Full)
Time & Date	X	XIf using the keyboard, press the Tab key to move to

the appropriate selections, and then send the configuration to the EXAD-8 by selecting the displayed **Configure eXAD** button. The configuration elements are described as follows:

Memory Mode
The choices are:

Stop When Full
Memory Wrap

This controls how the EXAD-8 handles the data it stores. The EXAD-8 has a storage capacity of 100 full waveform events (1 second length) and 500 history events. This means that it will store up to a total of 100 full records of vibration and sound data and 500 sets of peak particle velocity and peak sound pressure measurements (History). As the record length is increased, the number of available full waveform events decreases proportionately. If the EXAD-8 was configured to **Stop When Full**, when the memory is full, the EXAD-8 will not allow any further recordings until the data has been transferred and the unit was reconfigured to clear the memory. If the EXAD-8 was configured to **Memory Wrap**, then when the memory has been filled, the oldest recording will be overwritten by the newest recording. The Memory Mode can only be changed through the eXAD software running on the PC.

Suggestion: Operate in Stop When Full Memory Mode. This will ensure that the full waveform data will not be lost without the chance to offload the previously stored data.

Sample Rate
The Sample Rate Selections are:

1024 Hz
512 Hz

The eXAD-8, although storing at 1024 samples per second has an equivalent sampling rate of over 25,000 samples per second per channel (re measurement of peaks). The sample rate and cutoff frequency is selected based on the range of vibration frequencies in which you are interested. The current version of software and eXAD-8 firmware only allows a sampling rate of 1024 samples per second per channel. Future versions will allow many more options.

Trigger Mode
The Trigger Mode choices are:

Level
The selection allows the EXAD-8 to start recording based on a level, or threshold, of vibration and/or sound pressure levels. If the Level mode is selected, you must configure a trigger level for the geophone and/or microphone..

Manual
The Trigger Mode is how the EXAD-8 determines when to start recording. As an example, if the Trigger Mode is configured as Manual, the EXAD-8 will only start recording when the ENT key on the keyboard is pressed. This allows control of exactly when the EXAD-8 starts recording.

Trigger Source
When the Level trigger mode is selected, the eXAD-8 uses the trigger source and trigger level to determine when to begin recording. As an example, for a trigger source of geophone and a trigger level of 0.5 mm/s (0.02 in/s) the eXAD-8 will wait until the vibration level reaches 0.5 mm/s (0.02 in/s) before beginning to record. It is important to set the trigger to a level sufficiently high to avoid false triggers (from nearby construction activities, etc.) and low enough to ensure capturing of the vibration of interest.

Record Time
The Record Time selection allows you to configure the EXAD-8 to record for a length of time after the unit triggers. The maximum allowable record time for a single recording is 30 seconds. Set to record time long enough to capture the vibration and overpressure related to a blast.

Suggestion: Knowing the duration of the blast and the distance from the blast, the record time can be correctly set. Add 1 second to the blast duration and then add one second for each 300 meters (1000 feet) from the blast.

Sound Type
A-Weight
A-Weighted is selected for the evaluation of sound levels associated with human hearing.

Linear
Linear is selected for the evaluation of blasting induced overpressures.

Erase History
The eXAD retains the peak measurements from the last 100 events (triggers) and escape from triggers in the history buffer. When the **Erase History** box is checked, the History buffer will be erased.

Suggestion: Download and retain the history data on an occasional basis. Erase the history at the beginning of the season.

Configure eXAD
When the desired changes have been made to the configuration, it is time to send this information to the EXAD-8. By clicking on the Configure eXAD button will open a window warning that the memory (full waveform only unless Erase History is checked) will be erased. Press the OK button to transmit the configuration via the serial port to the EXAD-8. A short message should appear on the PC display (**eXAD Communications Open**). At the same time, a message will appear on the EXAD-8 display, **Communicating with PC**. When the data has been

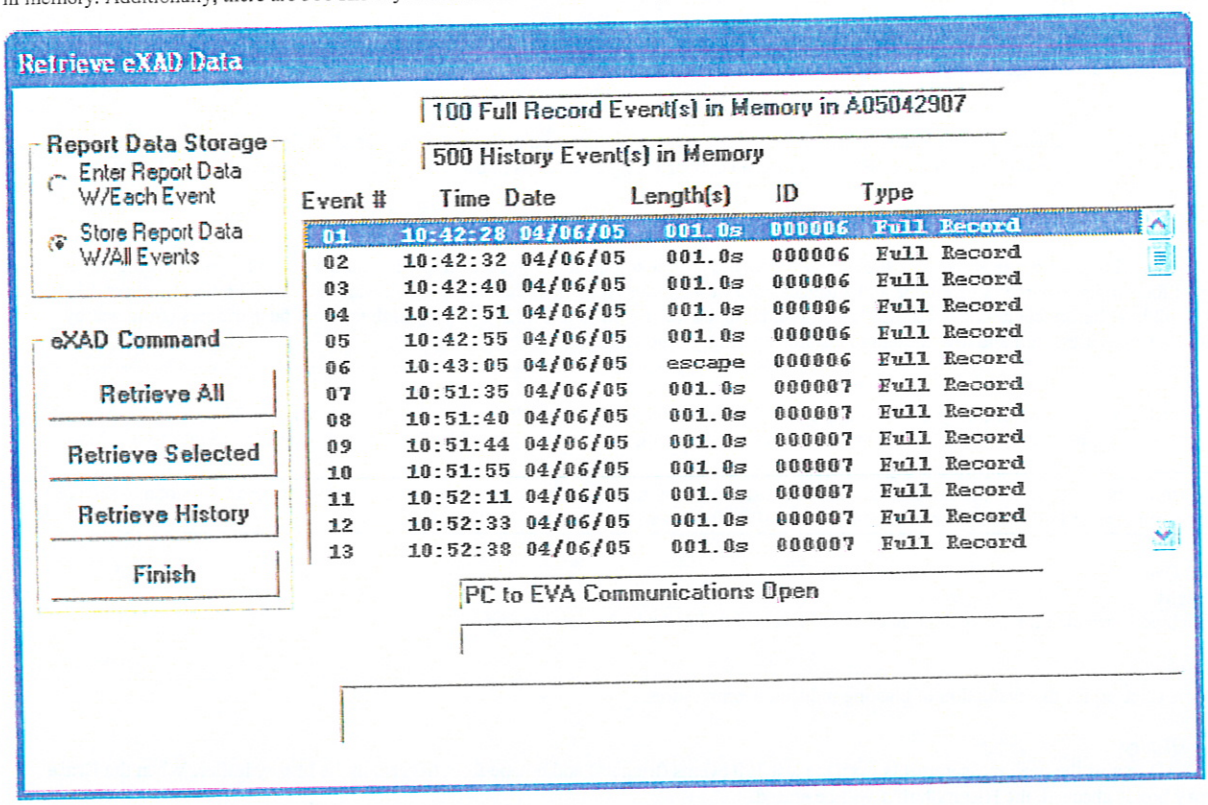
transmitted, the message will disappear from the PC display, and the EXAD-8 will restart with the new configuration. A success message will be displayed if the transfer was completed without problems.

Remember: Configuring the EXAD-8 through the PC will clear the EXAD-8 memory of stored events. Make sure that any events that you wish to save were Retrieved before configuring. The eXAD units of measure (mm/s or in/s) will be configured as the current PC software setting.

Suggestion: Watch the EXAD-8 display to verify that communications were completed. If there were any type of communications failure, it is possible that the **Communicating with PC** message will remain on the display. This means that the unit is still waiting for the end of the data. (It did not receive all of the data that it needs to configure). Should this happen, switch off and then restart the EXAD-8, check all connections, and go back to Configure eXAD.

Set eXAD Time & Date
This selection sends the time & date which is currently set in your PC. The time & date is very important to the EXAD-8 since all data files are time stamped, and the eXAD software uses the time stamp to create file names for the data that is transferred from the EXAD-8.

Retrieve eXAD Data
This selection is used to transfer data which has been stored in the EXAD-8 to the PC. The EXAD-8 and the PC must be connected by the EXAD-8 to PC serial cable. When this selection is made, the eXAD software communicates with the EXAD-8 and determines how many events are stored. It then displays a list of the events stored, the trigger time and date for each recording, and the length in seconds of each recording. To transfer, it is necessary to select either Retrieve All, Retrieve Selected, or Retrieve History under eXAD Command. Retrieve All is selected to transfer all events stored in memory. Retrieve Selected allows the user to transfer the highlighted event. (Use the up and down arrows or click with the mouse to highlight the desired event, then double click). The example below indicates that there are 100 events in memory. Additionally, there are 500 History Events in the eXAD-8 memory.



Two Report Storage options are available. They are:

Enter Report Data With Each Event
This selection forces the software to stop before the transfer of each recording to allow the user to enter Report Data.

Store Report Data With All Events
When this selection is made, the system allows the input of the Report Data before the first recording and then stores that data with all transferred recordings.

Retrieve All
When selected, all full record events are transferred from the eXAD-8 to the selected path on the computer.

Retrieve Selected
This option allows the user to transfer events that have been previously selected without having to transfer all events. To select an event, double click on each desired recording. This will place a double arrow marker next to that specific event. Then click on the Retrieve Selected button.

The Report form will open allowing the operator to enter information that will be archived with the record. After the Report Data has been accepted, the current data path is displayed. The user can then direct the data to any available directory. File names for the data files will be created automatically from the trigger time & date, and the EXAD-8 serial number. (The trigger time & date, is the time & date that the EXAD-8 triggered to record that particular event.) When the transfer is completed, click on the Finish button to end Communications between the PC and the EXAD-8.

Note: When the data is retrieved, the EXAD-8 memory is not cleared. If there is a communication failure for any reason, the process can be repeated. If you have previously transferred this particular data from the EXAD-8, that data will be overwritten.

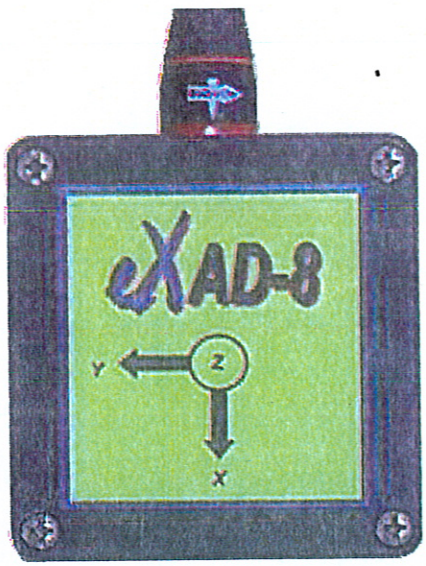
Suggestion: Verify that the recordings have been transferred properly by viewing the data graphically before clearing the memory of the EXAD-8. The memory should be cleared before next use of the system. It is best to clear the memory by reconfiguring the EXAD-8 using the PC

Retrieve History
The selection of Retrieve History transfers all stored events into a text file (named with the serial number) and also displays the history list.

EXAD-8 Operations

EXAD-8 Components

The EXAD-8 is a high accuracy vibration and sound pressure and sound level recorder, that has been designed specifically to record blast and construction induced vibration & sound. The basic components of the system are the triaxial geophone unit, microphone, internal electronics (digital & analog), liquid crystal display, 4 key keypad, Start/Stop switch, and battery. The system was designed to be reliable & rugged, but it is a high sensitivity measuring instrument and caution must be exercised. **Note: It is not necessary to take your PC into the field for eXAD operations.**



Triaxial Geophone Package

The triaxial geophone is the velocity (vibration) sensing part of the EXAD-8 system. It is stored on the left side of the keyboard plate. The electrical connection is made through the PMT cable and connector. Handle the geophone with care. **Damage can result if the package is dropped. The geophone package should only be opened by factory trained personnel.**

Axes of Sensitivity

The axes of sensitivity for the geophone package are called the X, Y, & Z axes. The X axis should be pointed toward the blast and Z is vertical. The geophone should be placed in the earth level to within +/- 10 degrees. Note: the X axis is sometimes called radial or longitudinal. The Y axis is sometimes called transverse. The Z axis is sometimes call vertical.

Microphone
The microphone is stored in the lid of the eXAD with a Velcro strap. It is attached to the EXAD-8 system by a cable (about 2 m), through the Mic connector on the top plate. The sound channel is designed to measure both air overpressures associated with blasting (Linear) and A-weighted, fast response, true RMS sound levels (A-Weight). This allows the EXAD-8 to record sound levels which are equivalent to what and how the human ear responds to noise.

Electronics
The internal electronics are low power CMOS circuitry and should not be handled by anyone other than factory, or factory approved, personnel. Be careful to avoid static discharges as damage could result. All signal conditioning and digital electronics are within the EXAD-8.

Liquid Crystal Display (LCD)
The EXAD-8 LCD is 4 lines by 20 characters, and with the keypad, provides the user interface while operating in the field. Never drop anything on to, or press on, the LCD, since it can be damaged.

KeyPad
The 4 key keypad allows the EXAD-8 system to be configured while operating in the field. A PC is not necessary to operate the EXAD-8 or change necessary operating parameters.

Battery & Charger
The battery is a 6 volt lead-acid gel-cel. Normal continuous operating time for the EXAD-8 is between 80 and 100 hours depending on temperature and age. The battery should never be allowed to discharge to below 5 volts, since battery life will be reduced. If it is allowed to discharge down below 4.5 volts, it may never recover even with charging, and will have to be replaced. Always charge the battery after use to a full charge. The supplied battery charger is the universal voltage type. The connector power jack is on the top plate of the EXAD-8. Always charge the battery **with the lid fully opened, and the EXAD-8 switched to the Off position.**

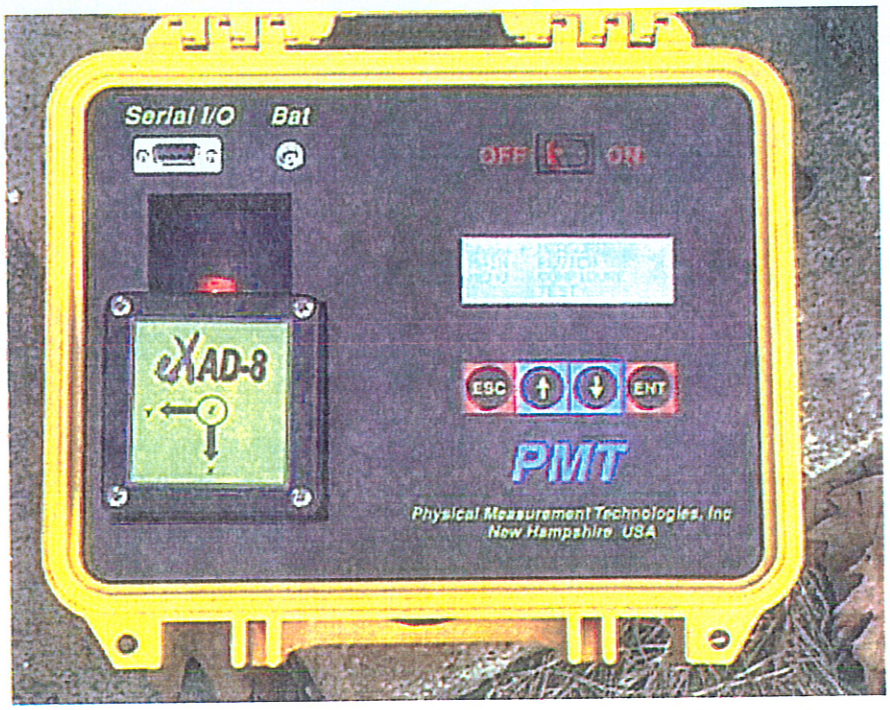
Switch the EXAD-8 to the off position, when not in use. Over discharging will damage the internal battery.

Operating the EXAD-8

Operating the EXAD-8 is very easy, but it is important to develop and follow a methodology or procedure which can be repeated exactly. In this way, measurements and results will be far more consistent. The purposes of measuring blasting induced vibration and sound include; accurate determination of vibration levels for compliance/insurance purposes, and design of blasts for maximum efficiency and minimization of vibration levels. Therefore, it is very important that the "how vibration is measured" , be standardized and repeated.

Placing the EXAD-8 (Blast)
When measuring for blast induced vibration, it is recommended that the EXAD-8 be placed adjacent to the structure of concern. It is always best to bury the geophone in the subsoil. This will improve consistency of measurements, minimize measured vibration levels, and will be more representative of the vibration induced at the structure.

Operating



Remove the geophone from its storage compartment and the geophone cable from its storage location. Connect the cable to the geophone and to the red connector on the right side of the eXAD-8 case. Remove the microphone and microphone holder from their storage locations. Insert the microphone holder into the socket on the right side of the case and microphone into the loop. Attach the microphone cable to the black connector.

Note: Cables and connectors are probably the most problematic part of any field instrument. It is important to keep the connectors clean. Handle them with care!

Switch the EXAD-8 to the On position and watch the display. Verify that the battery voltage is within acceptable limits. Also verify that the EXAD-8 time and date is correct. This is very important since file names and time stamps use the time and date. If it is incorrect, reset the time and date. The number of events recorded and the percentage of available memory, will then be displayed. Verify that there is sufficient memory to make your recording. The EXAD-8 configuration will then be displayed, including: Record Length in seconds (how long the EXAD-8 will record after it triggers), the Trigger Mode (Manual or Level), the Memory Mode (Stop or Wrap), and Sample Rate. Make sure that the Record Length is long enough to record the entire blast duration and the late arriving overpressure. If required, change the record length using the keypad. The Memory Mode and Sample Rate can only be changed using the eXAD software and PC. The Main Menu will now appear. Selections from the Main Menu are made by using the up↑ and down ↓ arrows and pressing the ENT key. Assuming that the geophone and microphone have been connected select TEST from the main menu. Then select SENSOR. This will dynamically test the geophone. The results of the geophone test will then be displayed. Pass indicates that the system is working properly. Fail indicates a problem. Check cable connections and geophone level, then retest.

MAIN MENU

MEASURE
REVIEW
CONFIGURE
TEST

Press the up or down arrows on the keyboard, and press ENT to select.

MEASURE
When it has been verified that the EXAD-8 is configured properly, a vibration recording can be made. Selecting MEASURE displays:

SINGLE
CONTINUOUS
REAL TIME

SINGLE
Selecting SINGLE allows the instrument to trigger and record a single event. After triggering, the peak measurements for each of the channels will be displayed. Selecting ENT will allow the instrument to trigger again. Selecting ESC will return to the Main Menu.

CONTINUOUS
Selecting CONTINUOUS allows the instrument to trigger, display the peak measurements and then immediately return to WAITING for a trigger.

After selecting either SINGLE or CONTINUOUS the display will indicate:

Set ID#

Set ID#
This is used to enter an identifier number for the recording. An example ID# would be the station or building number where the instrument is deployed. The ID# is selected by using the up and down arrows and pressing ENT to accept the displayed number. If the current entry is correct then select the ESC key to display the next screen. The ID# will be stored with field number 6 of the Report Data. It is a good idea to use this feature to keep track of your recordings.

After pressing the ENT key,

RECORD EVENT

PRESS ENT TO BEGIN
PRESS ESC TO EXIT

will be displayed.

After pressing the ENT key

WAITING

PRESS ESC TO EXIT

will be displayed. When the vibration and/or sound pressure reaches the trigger level the message RECORDING will be displayed. If in MANUAL trigger mode pressing the ENT key will initiate recording. After recording and storing the data the peak measurements will be displayed.

X= 12.5 mm/s 04-08-05
Y= 12.5 mm/s 10:57:05
Z= 12.5 mm/s MI=117dB

ENT/ RECORD ESC/EXIT

In English units:

X (R) = 0.50 in/s 04-08-05
Y (T) = 0.50 in/s 10:57:05
Z (V) = 0.50 in/s MI=117dB

ENT/ RECORD ESC/EXIT

The measurements displayed are the peak velocity for each channel, and the peak sound pressure level in decibels. Additionally the date (mm-dd-yy) and time of the trigger are displayed.

Note: The "peak particle velocity" that is reported is the greatest of the three channels.

The peak measurements are stored in the unit history (available under REVIEW).
If finished, press the ESC key to return to the Main Menu. The data is stored in non-volatile memory and the EXAD-8 can be switched to the Off position. **Always turn off the EXAD-8 from the Main Menu. Data files can be corrupted by switching the EXAD-8 off from any other than the Main Menu.**

REVIEW
Selecting REVIEW displays the peak measurements for all history events stored in memory (to as many as 500). Press ENT to review the next older set of measurements. The most recent measurements will be displayed first.

CONFIGURE
The Configure selection displays the menu:

CONFIGURE
SET OPERATIONS
SET TIME & DATE
CLEAR MEMORY

SET OPERATIONS
Selecting Set Operations allows you to change the EXAD-8 configuration without the PC. The first message to be displayed will be

SET UNITS OF MEASURE

ENGLISH
SI

Selecting ENGLISH will provide vibration measurements in units of in/s while SI will provide vibration measurements in units of mm/s. After selecting, the SOUND RESPONSE selections are displayed.

SET SOUND RESPONSE

LINEAR
A-WEIGHTED

Linear would normally be selected when measuring air overpressures, while A-Weight is selected for the measurement of sound levels. After selecting, the SET RECORD TIME window is displayed.

SET RECORD TIME

1 SECOND(S)

The SET RECORD TIME menu offers the ability to change the record time (time after trigger) from 1 to 30 seconds in 1 second increments. Change with the up and down arrows and press ENT to select. After selecting the TRIGGER MODE window is displayed.

SET TRIGGER MODE

MANUAL
LEVEL

MANUAL trigger is normally selected when the operator wishes to begin recording on command (pressing the ENT key while WAITING FOR TRIGGER). LEVEL trigger is selected when the operator wishes to have the instrument begin recording based on the trigger threshold of vibration and/or sound. If LEVEL was selected, then a choice of trigger source is displayed. The choices are:

GEOPHONE
MICROPHONE
GEO/MIC

The choice of GEOPHONE allows selection from 0.3 mm/s to 25.0 mm/s in 0.1 mm/s increments. In English units 0.01 in/s to 1.00 in/s, in 0.01 in/s increments.

The choice of MICROPHONE (linear) offers trigger levels ranging from 80 to 120 dB in 1 dB increments.

Suggestion: A geophone trigger level of 1.3 mm/s (0.05 in/s) has been found to be a good working geophone trigger level. If using a microphone trigger level it is suggested that it be greater than 110 dB

Set Date & Time
The set date & time window will be displayed.

SET DATE & TIME

DATE	TIME
MM-DD-YY	HH:MM:SS
01- -	- -

Use the up and down arrows to change the month to the appropriate month and press the ENT key. Repeat for Day (DD), Year (YY), Hour (HH), Minute (MM), Second (SS). Just pressing the ENT key will accept the present values.

Clear Memory
This selection allows the user to empty the EXAD-8 memory without resetting through a PC. To clear the memory it is necessary to confirm by selecting YES. It is best to clear the memory of the EXAD-8 by resetting the instrument using the PC (eXAD Communications: Configure eXAD/MMC). This will reset all internal variables.

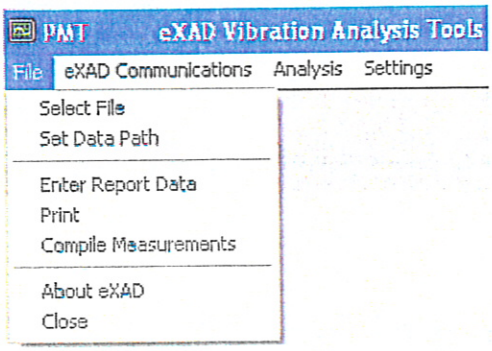
TEST
SENSOR
The TEST selection on the main menu allows the operator to test the geophone and the battery. If testing the geophone and a failure message is displayed, verify the cable connections and the level of the geophone.

BATTERY
This selection displays the present battery voltage. **A recharge warning will be displayed if below 5.2 volts. If the battery voltage drops below 5 volts, the eXAD will not allow further operations until the battery has been recharged.**

eXAD Software Vibration Analysis Tools

The eXAD software Vibration Analysis Tools is a powerful suite of tools designed to archive, analyze, and print blasting induced vibration and sound records specifically recorded with the EXAD-8 system. The tools allow you to display the acceleration (x,y, & z channels) (waveforms) and sound level (dB(A)) time histories. It also allows various levels of manipulation and control so that you can Expand and Zoom the time histories, scroll through the data, and time locate specific areas of interest.
Before starting the Vibration Analysis Tools it is necessary to select an event or recording to analyze. Choose the File selection from the top Menu Bar.

FILE



The selections are Select File, Set Data Path, Enter Report Data, Print, and Compile Measurements.

Select File
This selection allows you to choose an event to analyze. A list of files will be displayed along with the trigger time & date, and the Report Data field (15 characters) which had been selected. Highlight the event of interest and press Enter or click on the OK button. **This record will become the current event. It will remain the current event until a new record is selected or you exit the software.** After you have selected a record you can add or edit the Report Data or display the analysis.

Set Data Path
This allows selection of available directories in which to store or select data.

Enter Report Data
Once a record has been selected, text information can be stored with each report. There are 10 fields with the Titles that were entered when the eXAD software was configured. (The titles can be changed after selecting the recording for storage with the recording.)

Suggestion: Include report information that will help identify the record when you have long forgotten what and why. It is good practice to enter common Report Data before transferring to the PC.

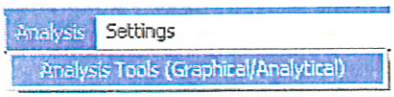
PRINT
This choice allows the selection of one or multiple files to print. Double click on the files that you wish to print then click on OK to send the files to the system printer.

Compile Measurements
This allows the measurements from multiple files to be compiled into a text file that can be imported into a spreadsheet or data base. Operations are similar to printing except a file will be created. The file name must be entered to create the text file.

About eXAD
This displays the copyright information and the software version.

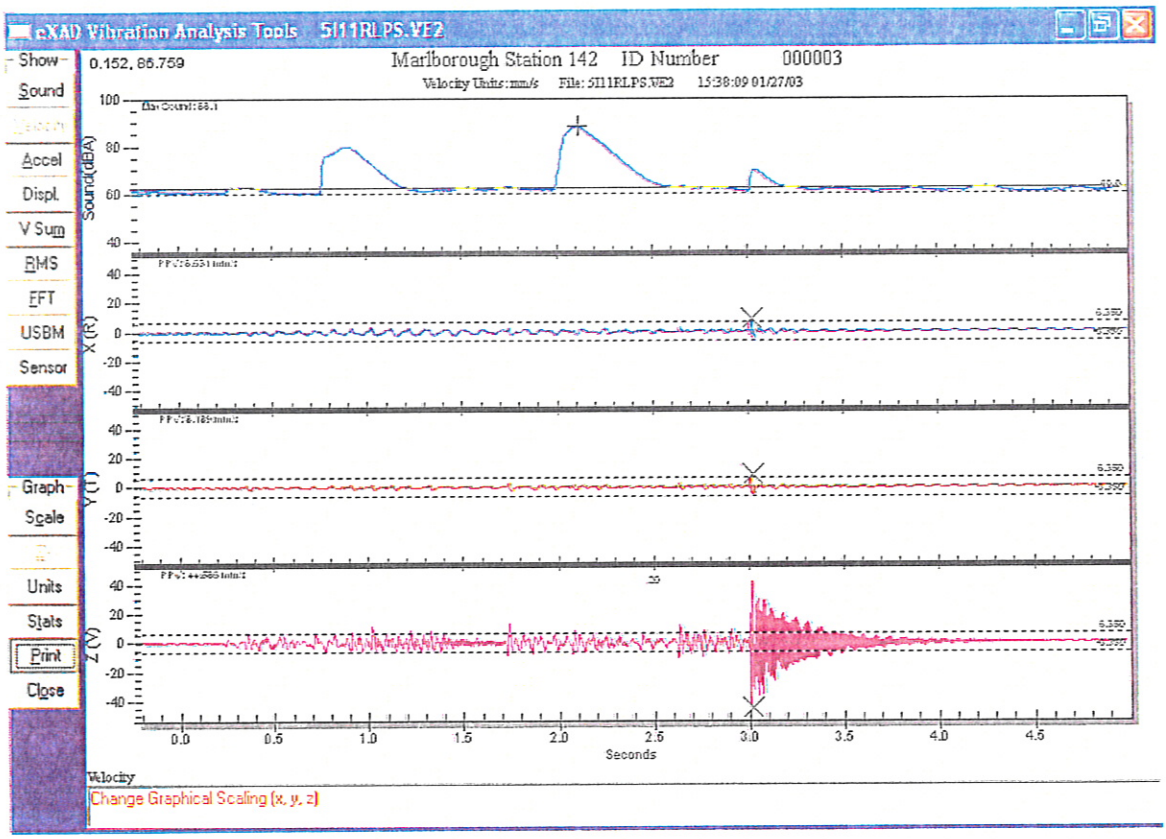
Close
This end the program.

eXAD Vibration Analysis Tools



Once a file has been selected, the Analysis Tools can be used to graphically display, analyze, and print the data. Choose Analysis from the top Menu Bar. Press Enter or click on Vibration Analysis Tools.

The graphics screen (Figure 1) is divided into 4 graphics windows. The top window is used for displaying the Sound Level time history and the 3 axes of vibration are displayed in the bottom 3 windows (X,Y,Z) for extended analyses. At this point the graphics screen will be drawn. The current event data will be loaded and drawn on the display (See Figure 1). Once the data has been displayed all of the tools are available. The available commands are listed on the command bar on the left edge.

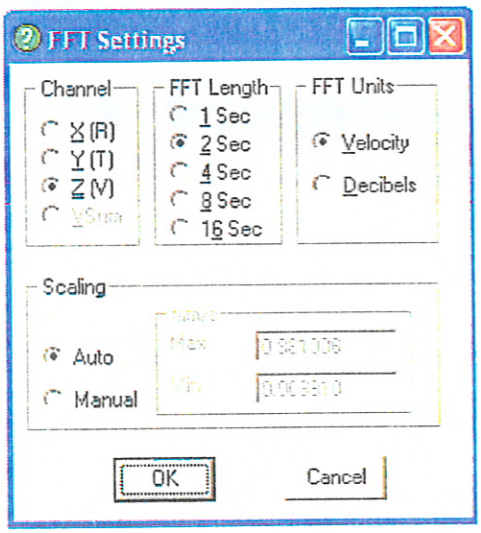


Command Bar Definitions

Sound - Display Sound Level Time History in Top Window
Vel. - Display Velocity Time Histories (default on start-up)
Accel. - Calculates (from the velocity time histories) and displays motion in terms of acceleration (milli(g)s)
Displ. - Calculates (from the velocity time histories) and displays motion in terms of displacement (mm or in)
V Sum - Display Vector Sum Time History in Top Window of User Selected Channels
RMS - Display Root Mean Square Time Histories of All Channels (x,y,z)
FFT - Display Fast Fourier Transform of User Selected Data. Place Cursor Bar at position of interest, Click on FFT, Select Channel, Select length of section to analyze (Spectral Analysis)
Scale - Controls Visual Scale
Z- Undo Zoom - You can zoom on a section of the time history by moving the mouse cursor to the point of interest and holding the left mouse button down while dragging and creating a zoom box. Select the Z- button to return to a normal display.
manual - With this switch on, the scaling can be manually controlled by the operator.
Units - Set Units of Measure from Within Graphics Display (The data will be re-calculated & re-drawn)
Stats - Statistics (Measurements) Displays Measurements, Performance Measurements, and Analysis. The Page can be printed or closed. (See **Sample Report at back of Manual**)
Print - Print the Graphics to the System Printer
Close - Close Vibration Analysis Tools Data Display

FFT (Fast Fourier Transform)
The FFT is an extremely powerful trouble shooting tool which provides amplitude and frequency information about the vibration of interest. This is particularly useful for vibration resulting from a repeating or cyclical source

To utilize the FFT, **move the cursor bar to the beginning of the section of interest** and select the FFT button. Move the mouse cursor to the point of interest and when the cursor changes to a hand, click with the left mouse button. This will place the vertical cursor bar at that location. The FFT is used to analyze the vibration beginning at that point.

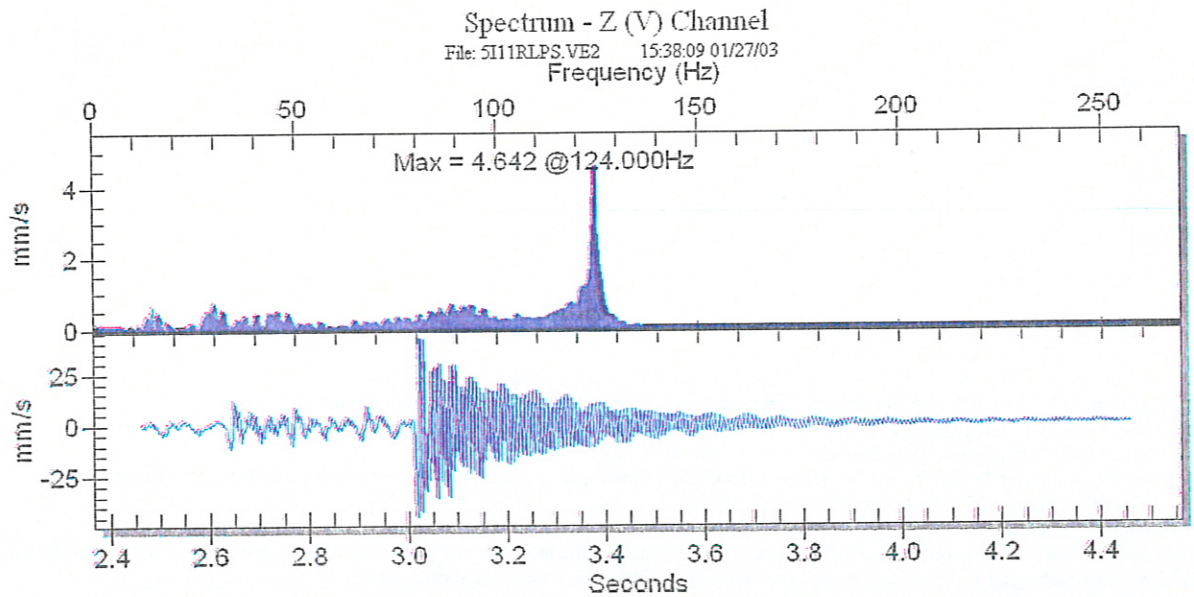


Select the Channel and FFT Duration (Click on OK)

Note that selecting a longer FFT Length provides increased frequency resolution but analyzes a longer section of data.

FFT Display

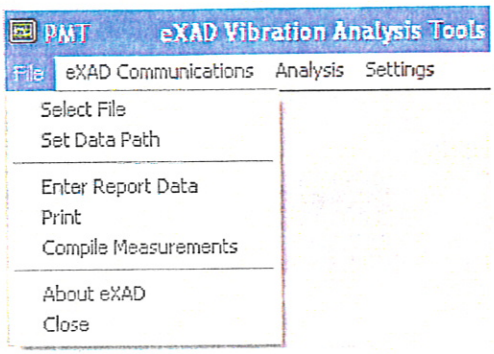
The resulting FFT page presents an analysis (upper window)of that section of the z axis (lower window) channel time history. The analysis, or spectrum offers a presentation of vibration level versus frequency. The spectrum below shows significant vibration level at various frequencies. The dominant frequency on the graphs below is at 124 Hz.



Printing and Output eXAD Data

There are several methods for printing or outputting eXAD data for presentation or analysis purposes. The most common approach is to print individual reports for each recording.

Printing



The eXAD software provides three methods of printing.
A quick screen print can be performed from the Vibration Analysis Tools graphics display by clicking on the Print button.
The Stats (statistics) page can be displayed from the graphics display.
The more formal method is to select **eXAD Print** from the File menu on the top menu bar.

After selecting Print, the directory list will open. Select the record to be printed by double clicking on the record of interest, or highlighting and pressing the S key.

International Blasting Services
Marlborough, NH USA

Record Analysis

File Name:	6L1SCALF.VE2	eXAD-6 Serial Number:	A04042829
Trigger Time:	07:37:43	Firmware Version:	1.0
Trigger Date:	04/12/05	Record Length:	5s
Monitor Start Time:	07:37:40	Cutoff Frequency:	256 Hz
Monitor Start Date:	04/12/05		
Software Version:	.54.0.1		

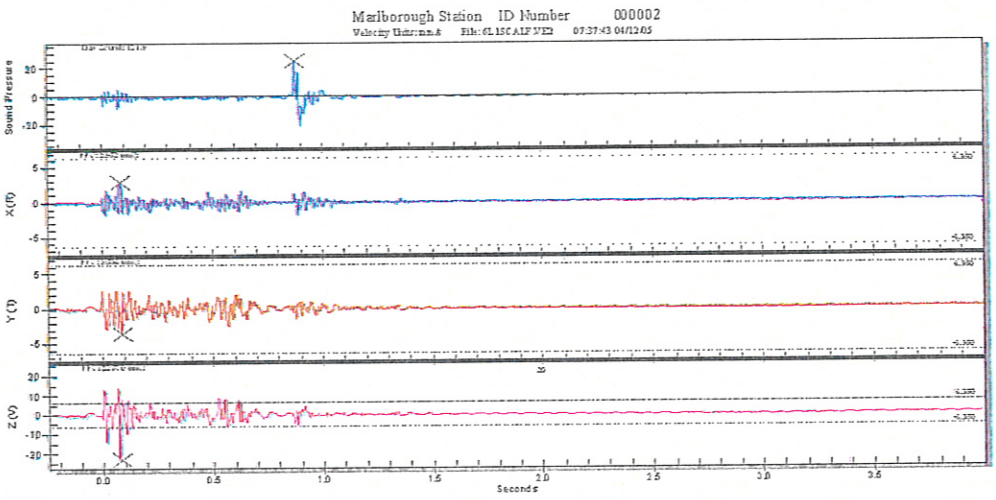
Measurements

Vibration Analysis	X (R)	Y (T)	Z (V)
PPV - Max 0 to Peak (mm/s)	2.952	3.538	22.570
Time of Peak (s)	0.085	0.092	0.081
ZC Frequency at Peak (Hz)	39.4	46.5	54.0
Peak Vector Sum (mm/s)	22.706 @80ms		
Max Acceleration (milli(g)s)	64.765	88.779	537.407
Max Displacement (mm)	0.013	0.019	0.093

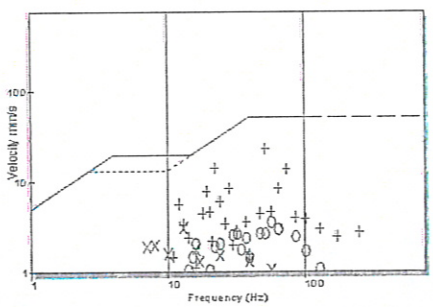
Sound Pressure Analysis	
Max dB (PA)	121.9 (24.9200)

Description

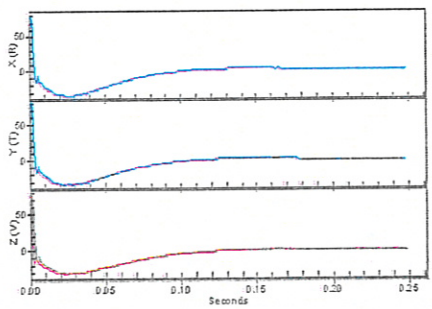
Project	Marlborough Quarry
Client	New Hampshire D & B
Operator	G.P. Lorsbach
Company	PMT, Inc.
Location	Marlborough Station
ID Number	000002
Conditions	T=0F, Wind From NW @20
Comments	Sample Data
Distance	500 Feet
Comments	



Analysis RE USBM RI8507



Sensor Test Data



The Worlds Standard of Measurement . . .
Blast, Construction, Structural Vibration & Sound

Physical Measurement Technologies, Inc., introduces the eXAD-8 seismograph and eXAD Vibration/Sound Analysis Tools software as the new standard in motion and sound measurement. Utilizing our entirely new eXPeak architecture, the eXAD-8 is designed to eliminate the inaccuracies associated with existing older seismograph designs. The eXAD-8 system was created to measure, analyze, and document blast/construction/structural vibration and sound, absolutely, easily, and at a **very low cost!**

Design Concept Overview – The eXad-8 system is a data collection system that is designed to overcome the inherent weaknesses associated with traditional sampling seismographs. PMT has created a new combined analog/digital concept that ensures that peak measurements are captured accurately and are repeatable. All standard sampling seismographs have the same problem; **repeatability**. Specifically, when two seismographs are placed side by side in a field situation, the **difference in the peak measurements can be as much as 100%**. However, when placed on a shake table, seismographs will generally be within 5% of each other. **This is a problem!**

PMT has solved these problems by creating the unique eXPeak architecture. This is an entirely new synthesis of analog & digital electronics, and steep slope anti-aliasing filters. The system tracks and stores the signal between samples and eliminates high frequencies that have no effect on structural damage. This new approach provides better than 95% coverage (960 out of every 1000 microseconds) and an equivalent sampling rate of greater than 20,000 samples per second. This is truly an amazing feat! **Accuracy is not compromised!**

High Accuracy Vibration and Sound Measurement, at Low Cost - The eXAD system is designed to be highly accurate in the short and long term. The system architecture (Division of Data Collection & Analysis/Printing) ensures against obsolescence and reduces costs. By separating the data analysis from the instrument, software upgrades keep the system current, and on the leading edge of vibration analysis. PMT is committed to continuous improvement and minimal cost. PMT will provide **technical support and software upgrades at no charge!**

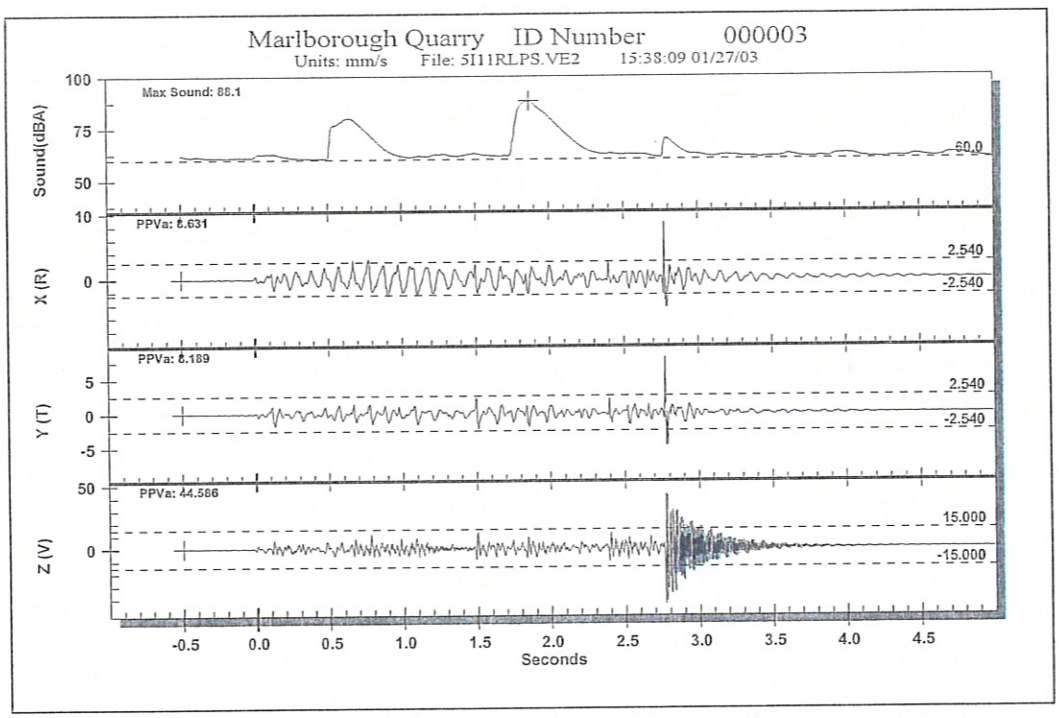
PMT

Physical Measurement Technologies, Inc.
P.O. Box 400, 4 Ling Street
Marlborough, NH 03455 USA
Voice: 603.876.9990
Fax: 603.876.9995

World Standard in High Accuracy Vibration & Sound Measurement

Field Operations with a Field Tough Instrument - The ℵAD system is particularly easy to operate, both in the field and in the office. About the size of a notebook computer; operation is simple and fast. The system can be configured for use on-site, without having to carry a PC with you. Simply connect the geophone and microphone, turn it on and select monitor. The data is automatically stored in non-volatile memory with room for over 300 seconds of data. The ℵAD-8 is rugged enough so that it can go anywhere at anytime with few concerns. Shipping and field operations with a high accuracy instrument are no longer a worry. Geophone cables can be replaced in seconds.

ℵAD Vibration/Sound Analysis Tools - *Science in the Software* - The included ℵAD Vibration/Sound Analysis Tools software is a powerful suite of analytical tools for vibration and sound measurement, in a fully integrated Windows™ based environment. It offers unmatched analysis of all motion and sound levels, yet is easily used by almost anyone. Analytical capabilities include time history zoom of data, comparison of data with respect to user defined vibration limits, spectral analysis (FFT), and RMS vibration and sound level measurement (A-weighted, fast response). Of course, the ℵAD software also prints standard reports on your office printer.



ℵAD-8 Specifications

Microprocessor: 8XC52 Family
Display: 4 Line by 20 Column Liquid Crystal
Keyboard: 1 X 4 Sealed Membrane
Communications: Serial RS232, 57600 Baud
Clock: Integrated Battery Backed Real Time Clock
Battery: 6 V, Rechargeable Lead Acid Cel, 200 Hrs/Charge
Battery Charger: Universal Voltage
Sensors: 3 Geophones (x,y,z Triaxial arrangement)
1 Condenser Microphone
A/D Converter: 13 Bit Self Calibrating
Anti-Aliasing Filters: (Velocity Channels)
Software Selectable Cutoff : 250 to 2500 Hz

Sample Storage Rate: 1024 SPS/Channel to 5000 Hz (Switchable)
Frequency Response: Velocity 2 to 250 Hz
Frequency Response: Mic. A-Weighted Fast Response 8 KHz
Type 2S True RMS Sound Level Measurement, or Linear 2 - 250
Range: Geophone +/- 80mm/s, Mic: 40 to 90db(A), 90 to 140dB (Linear)
Resolution: Vibration 0.02 mm/s, Mic: 1 dB
Repeatability: Vibration: +/-5% Impulsive Input, Sound: 1dB
Base Level Noise: 0.1 mm/s
Data Storage: Over 300 Events, 2MB memory standard
PC Requirements: Windows 9X, Windows 2000, Windows XP

Specifications Subject to Change Due to Continuous Improvement